Title: Chances are More than Just a Chance

Brief Overview:

This learning unit will demonstrate to the students how probability is used to calculate chances or likelihood of a given event occurring. Students will also be able to distinguish the difference between theoretical and experimental probability. Students will also be able to explain the importance of using a large numbers of trials using experimental probability.

NCTM Content Standard/National Science Education Standard:

Data Analysis and Processing
- Students will demonstrate their understanding of proportions and a basic understanding of probability to make and test conjectures about the results of experiments and simulations.
- Students will demonstrate an understanding of and will apply basic concepts of probability. They will select and use appropriate statistical methods to analyze data. Students will develop and evaluate inferences and predictions that are based on data.
- Students will design and/or conduct an investigation that uses statistical methods to analyze data and communicate results.
- Students will use simulations to make statistical inferences from data to estimate the probability of an event.
- Students will make informed decisions and predictions based upon the results of simulations and data form research.
- Students will communicate the use and misuse of statistics.

Problem Solving, Reasoning and Proof, Communication, Connections, and Representation
- These five process standards are threads that integrate throughout the unit, although they may not be specifically addressed in the unit. They emphasize the need to help students develop the processes that are the major means for doing mathematics, thinking about mathematics understanding mathematics, and communicating mathematics.

Grade/Level:

Grades 6 – 8, Algebra I

Duration/Length:

Three 90 – minutes lessons (Six 45 – minute lessons)

Student Outcomes:

Students will:
- Be able to define probability and state ways that it is used in real world situations.
- Be able to demonstrate their abilities to calculate theoretical probability.
- Be able to conduct an experiment and calculate the probability.
- Be able to explain the difference between theoretical and experimental probabilities.
- Be able explain the importance of using a large number of trials when conducting experimental probability.
- Be able to construct simulations and apply the appropriate devices for their simulations.

Materials and Resources:

- Six–Sided number cubes.
- Coins
- Spinners (4, 5 & 6 sections)
- Colored cubes
- Paper bags
- Calculator (TI-83+ or TI-84)
- View screen
- Graph paper
- TI Explorations Book 2004
- Paper Clips
- Work sheets
    - Probability Notes
    - Decimals and Percents Warm–Up
    - Scavenger Hunt
    - Probability Classwork
    - Fair or Unfair?
    - Probability Homework
    - Hero Figures
    - Simulation Table

Development/Procedures:

Lesson 1:   Pre-assessment: – Begin the lesson by reviewing prerequisites for this assignment. Use the "Decimals and Percents" warm-up activity to review with the students the procedures for converting fractions to decimals and percents and vice–versa.

Discuss different events and the likelihood of each event occurring. Allow the students to tell why some events are more likely to occur than others.

Launch – Prior to the beginning of the class, hang the 6 scavenger hunt questions around the classroom (each question is on a separate sheet of paper.) Also prior to the beginning of class, place nine red cubes and one blue cube in a paper bag. Ask how many students think they can pick the blue cube out of the bag, without looking in the bag while they are picking. Ask the class *how many* students think they will pick the blue cube and explain their reasoning. Allow those students who think they can do it to try, making sure the number of students who make an attempt is recorded. Record the number of students who actually picked the blue. Allow students to continue to pick cubes until you have a round number such as 10, 20, 25, or 30 to keep calculations simple. Ask the students how this information could be written as a fraction and what the fraction means. Change the factions to decimals and percents. Demonstrate how this activity is an example of probability and how the outcome may be different for each experiment.

Teacher Facilitation – Develop the definition of probability with the students. Provide the students with samples of probability and solicit the students for other samples of probability. This information can be recorded on the board or overhead projector for the students to copy. Refer to the "Probability Notes" for definitions and class examples. Consider copying portions of these notes for students as a reference at the end of the lesson.

Student Application – Instruct the students to complete the "Scavenger Hunt". The students will circulate around the room answering questions on probability. They will tell if an event is experimental or theoretical, and tell if the event is bias or unbiased.

After a brief discussion of the results from the "Scavenger Hunt", the students will complete the worksheet "Probability Classwork" independently at their seats. Each # question on the Classwork worksheet refers to the corresponding # question on the scavenger hunt (ex. # 1 on the Classwork refers to # 1 on the scavenger hunt)

Go over the answers from the "Probability Classwork" worksheet, paying close attention to question # 2.

After the teacher goes over the answers from the Classwork, the teacher will then introduce the calculator into the lesson and the students will use the calculator to conduct experiments.

The teacher will demonstrate how the different simulations (ex. Coin toss, dice roll, spinner and random numbers) can be used for different situations. Demonstrate how each can be adjusted for different situations (ex. True or false, (coin toss), dice (odd or even) 1, 2, 3 odd 4, 5, 6 even, random numbers even (true), odd (false).

The teacher will demonstrate why some simulations are better for different situations.

The teacher will demonstrate the dice roll showing the probability with 20 tosses, then compare that to three tosses, and then to 500 tosses. This will show how the more times you perform the experiment, the closer the experimental probability comes to the theoretical probability. At this point, the teacher will introduce the Law of Large Numbers (refer to teacher notes).

The Law of Large Numbers states that the greater the number of trials in a probability experiment, the closer the result is to the theoretical probability of any outcome.

The lesson will conclude with the students completing the worksheet "Fair or Unfair?" as an assessment to determine the students understanding of the lesson.

Embedded Assessment – The students will be assessed throughout the lesson through discussion and from the teacher observation. The students will also turn in their Fair or Unfair worksheet.

<mark>Reteaching/Extension</mark>

- As an extension for those students who have not completely understood the lesson, discuss what theoretical probability predicts for tossing a coin six times (3-head, 3-tails) then have a student perform a coin toss six times and discuss the theoretical probability and the experimental probability.
- As an extension for the students who have an understanding of the lesson, have them to write a paragraph comparing theoretical and experimental probability.
- As an extension to this lesson, the students can complete the homework worksheet.

Lesson 2   Pre-assessment – Begin the lesson by reviewing the calculator notes from the previous day, with special attention given to the

random number generator. Be sure to explain how each simulation is used and the appropriate use of each. Discuss how the simulations are used to represent events. This can be done in a variety of ways. For example ask the students using the random card generator on the calculator who can draw a king on the fewest number of trials and who can draw a king on the greatest number of trials?

Launch – Introduce the "Hero Figures" simulation by reading the first paragraphs with the students.

Teacher Facilitation – Allow students time to answer the questions that follow the simulation's introduction. Review these questions as a class, clarifying any problems. Instruct the students to complete the simulation individually as well as in groups.

Student Application – In a THINK, PAIR, SHARE style, have the students conduct the simulation. During this activity, the students will work individually in pairs and in groups. Each student will conduct the experiment (20) times by themselves. Stop the students and discuss the results from the individual trials before the student pair up with another student.

Instruct the students to combine their totals with their partners' totals. Next, they will combine their total with the totals of another pair. This total now includes the outcome of four students. After each total have the students calculate the probabilities and compare the experimental probability to the theoretical. Have students discuss with their partners or groups, the difference in the experimental and the theoretical probability and how the experimental probability changed as they increased the total number of trials.

Now total all of the students' trials and compare the probability of the whole class with groups and with the theoretical probability. The teacher and the students should discuss the results of the data. The teacher can use the following questions to lead the discussion.

1. What are you noticing about the data?
2. Can you predict what will happen if we continue to add trials to our data?
3. Will the theoretical probability and the experimental probability ever be the same?

Embedded Assessment –

The students will be assessed throughout the lesson as they work threw the activity and as they give their answers orally.

Reteaching/Extension:

- As an extension to this lesson, have the students complete a writing assessment for homework. Assign them to write at least two situations where probability can be used. The students should tell what type of probability it is (experimental or theoretical), and they should also tell if the event is fair or unfair.

Lesson 3   Pre-assessment – Review the prior nights' homework by having the students give oral explanations of their probability situations and the types of probabilities they determined it to be. For students did not do the homework, the teacher can give the students example of where probability is used.

Launch – Discuss with the students the binary system and explain how it is used with computers. Explain how the binary system only uses the numbers '0 'and '1'. Demonstrate how a connection is represented as either opened or closed by a '0', representing open, and '1', representing closed.

The teacher will discuss the definition of a simulation and how to conduct a simulation with the students.
A simulation is a model of a real-life situation. A simulation can be conducted using random tables, dice, cards, spinners, or a random item generator on a calculator or a computer. (Note to the students that a simulation does not guarantee accurate results. It should only be used for estimating.)

Distribute a simulation table (a binary table is included) to each student that contains only the digits 0 and 1 and a tally sheet Tell the students that this table represents free throws made by different NBA players. Allow the students a couple of minutes to analyze the table. Ask students what conclusions can be made from this data. (Answers will vary)

1. Ask the students which NBA player could the table represent if 1 means they made the shot.

2. Ask the students which NBA player could the table represent if '1' means they missed the shot.

The teacher can record the student's response on the board or the overhead.

.

Have the students decide as a class if '0' will represent a made shot or a missed shot. Inform the students that the school will be having tryouts for the basketball team.

Have the students to randomly put their pencil on a number to see if they were on the team, how many free throw shots they would make. Have them to conduct 20 trials.

Have one or two of the students to shoot a paper ball to the trash can twenty times to see if their experimental probability matches their simulation probability.

The teacher should record the results on the board and the students should record the results the tally sheet. After the students have recorded the information, they should answer the question that go along with the activity.

If time permits, assign students the task of coming up with situations that can be conducted using the binary table.

Embedded Assessment - The students will be assessed throughout the lesson by teacher observation and oral responses. The teacher will circulate are the room asking the students questions as they work. The students will also be assessed on their ability to calculate the percentage of shots from their simulation as well as the percentage of shots from their trash can experiment.

Reteaching/ Extension

As an extension to this lesson, have students conduct a simulation to determine how many of the 15 quizzes they will pass for the quarter. Inform the student that each time they perform a simulation, they must define how the simulation will work.

Summative Assessment:

The teacher will informally assess the students by observing the students as they work on the activities and experiments, as well as by their oral responses. The students will as be assessed on their written class work and homework.
A formal assessment is included in this CDU. The formal assessment is a BCR from the 2006 H.S.A.

Authors:

Darryl W. Green   Kimberly Johnson-Green
Marley Middle School   Harbor City High School
Anne Arundel County, MD   Baltimore City, MD

Definitions

Experimental Probability

We use ratios to show how likely, or unlikely, an outcome might be. This ratio is called the **probability**.

For example, the ratio $\dfrac{45}{100}$ represents the number of heads which appeared when a penny was tossed 100 times. This ratio is the probability that the toss was heads.

The ratio for probability can be thought of as:

$$\text{Probability of event} = \frac{\text{number of times it can occur}}{\text{total number of possible outcomes}}$$

Ratios are most often expressed in the form of a fraction. Fractions, however, can also be expressed as decimals or percents. So probabilities may be expressed as fractions, decimals or percents.

*** As the chart above shows, probabilities range from 0 to 1. If an event is impossible and will never occur, the probability is 0. If an event is absolutely certain to occur, the probability is 1. Otherwise, the value of a probability is between 0 and 1.

Theoretical Probability

Theoretical probability is the ratio of the number of ways the event can occur to the total number of possibilities in the sample space.

$$P(E) = \frac{n(E)}{n(S)} = \frac{\text{number of ways to get what you want}}{\text{the total number of possibilities}}$$

- **Possible experiments with fair, unbiased objects may include:**
  What is the probability of rolling a 3 with one die?
  What is the probability of drawing a king from a deck of cards?
  What is the probability of drawing a red marble from a bag containing 3 red marbles and 5 blue marbles?
  What is the probability of tossing a tail using a penny?

- **Possible experiments with biased objects:**

Glue a dime to a nickel to create a weighted coin. Be sure the weighted coin has a head and a tail. What is the probability of tossing a head?

Toss a paper cup. It may land in one of three positions: on its top, on its bottom, on its side. What is the probability of the cup landing on its top?

Minimum number of trials: 100

Tabulate information as it is gathered:

Group member	Number of 3s.	Number of rolls
Sue	9	30
Joe	12	30
Wally	18	40

Cumulative number of rolls: 100

Cumulative Relative Frequency (Probability): $\dfrac{39}{100} = .390$

You may also wish to have students compare their results with the theoretical probability, and write a short paragraph explaining the comparison.

Classroom Idea

A box contains 20 slips of paper. Five of the slips are marked with an "X", seven are marked with a "Y", and the rest are blank. The slips are well mixed. Determine the probability that a blank slip will be drawn without looking in the bag on the first draw. Have students determine the probability theoretically and then have each conduct the experiment with ten trials and see how close the empirical probability was to the theoretical probability. Combine data from all students in the class to see if a larger number of trials will result in an empirical probability that more closely resembles the theoretical probability.
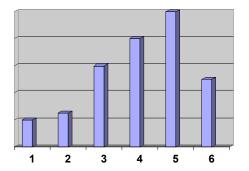
Law of Large Number Notes for Teacher

To help your students better understand the distinction between theoretical and experimental probabilities, have students compare the frequencies of the outcomes after each trail using a visual scale called a Qualitative Scale of Evenness (QSE). It is important to note that students are working with qualitative scales, not quantitative scales: they are not calculating experimental probabilities until the end of the activity. Using the QSE that they create, students rate the bar graph distribution created in the Probability Simulation Apps using a scale from 1-5, where 1 indicates that none of the bars are close to the same height and 5 indicates that all of the bars that none of the bars are close to the same height (a highly unlikely, but perfect distribution).
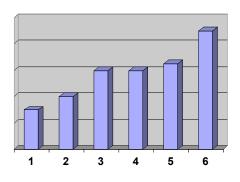
It is important that the entire class determines and agrees upon the ratings to be used in their QSE. After the students have reached a consensus, have the rating scale available for all to reference, either as a hand-out of on a large visual display. Remind students that they all are to use this rating system when evaluating their graphs.

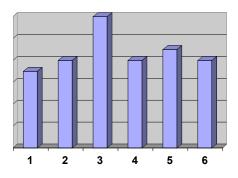This Exercise refers to Activity one from the TI Exploration Book 2004

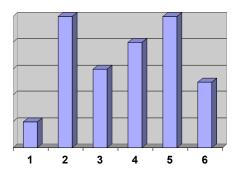Qualitative Scale of Evenness (QSE)

Rating of a 1-No bars have the same height

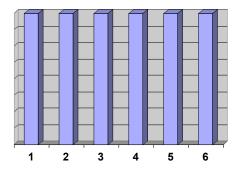Rating of a 2-Few bars have the same height

Rating of a 3-Most bars are similar in height

Rating of a 4-Bars are very similar in height

Qualitative Scale of Evenness

Rating of a 5-All bars are exactly the same height

Simulation Notes for Teacher:

- (A simulation is a model of a real-life situation. A simulation can be conducted using a variety of situation. A simulation is a method for estimating probability.

- The results of a simulation will not always be accurate. It should only be used for estimating.

- The more trials in the simulation, the more reliable the results.

- The Key to choosing a simulation is finding a situation that has the same
   Probabilities as the situation you are trying to predict. (Make sure the method is an appropriate method for the situation).

- Simulations should involve data that are easier to obtain than the actual data
   you're modeling (Typical simulations involve coin flips, decks of cards, random number tables, spinners, random number generators on the calculator or the computer,

- When designing a simulation you must consider the outcomes (the theoretical probability).

- You must decide what one trial looks like and how you will conduct one trial.

Probability   Name: _____
Warm Up

Part A: Write each fraction as a decimal and as a percent

1. $\dfrac{3}{4}$

2. $\dfrac{1}{10}$

3. $\dfrac{5}{6}$

4. $\dfrac{2}{3}$

5. $\dfrac{1}{2}$

Part B: Answer the following question.

6. What is the likelihood that it will rain today? Choose one of the percentages from above, and explain your reasoning.

Probability   Name: _____
Warm Up Answer Key

Part A: Write each fraction as a decimal and as a percent

1. $\dfrac{3}{4}$ .75   75%

2. $\dfrac{1}{10}$ .10   10%

3. $\dfrac{5}{6}$ .83   83%

4. $\dfrac{2}{3}$ .66   66or 67%

5. $\dfrac{1}{2}$ .50   50%

Part B: Answer the following question.

7. What is the likelihood that it will rain today? Choose one of the percentages from above, and explain your reasoning.

    It is a 50% chance that it will rain. Answers will vary.

Scavenger Hunt
Question # 1

Janice applies for 4 jobs. She thinks there is a 50% chance that she will be offered each of the jobs.

a. Is this an example of experimental or theoretical probability?

b. Is this event bias or unbiased?

Scavenger Hunt
Question # 2

Mrs. Green has a bag that includes 1 blue marble and 9 red marbles. She takes a marble out of the bag and records its color. Then she places the marble back in the bag. She repeats this 30 times. Her results are shown in the table below.

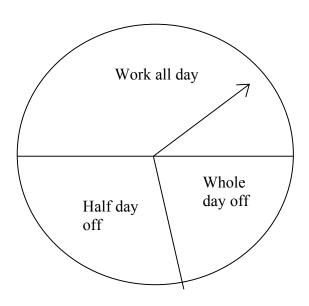| Color Selected	Number of Times Selected
red	20
blue	10

a. Is this an example of experimental or theoretical probability?

b. Is this event bias or unbiased?

Scavenger Hunt
Question # 3

Kim will flip 3 dimes. The 8 possible outcomes for the 3 flips are listed below. Each has an equal chance of occurring.
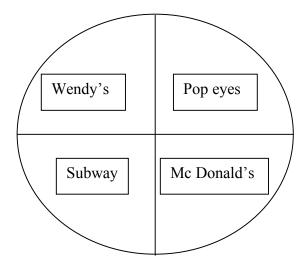
- heads, heads, heads
- heads, heads, tails
- heads, tails, heads
- heads, tails, tails
- tails, heads, heads
- tails, heads, tails
- tails, tails, heads
- tails, tails, tails

a. Is this an example of experimental or theoretical probability?

b. Is this event bias or unbiased?

Scavenger Hunt
Question # 4

Marley is having a contest for their teachers. Each teacher the spinner below to see if they can have a day off with pay, have an half day off with pay, or if they have to work all day.

a. Is this an example of experimental or theoretical probability?

b. Is this event bias or unbiased?

Work all day

Whole day off

Half day off

Scavenger Hunt
Question # 5

Jamie spent the spinner shown below to determine where to eat lunch.

| Wendy's | Pop eyes |
| Subway | Mc Donald's |

a. Is this an example of experimental or theoretical probability?

b. Is this event bias or unbiased?

Scavenger Hunt
Question # 6

The 1100 students at Marley middle school were ask to name their favorite subject as they entered the school. The results are shown in the table below.

Favorite Subject	Number of Students
Math	220
English	180
Social Studies	133
Science	200
Gym	250
Music	117

At lunchtime a student was selected at random and asked what is his/her favorite subject. What is the probability that the students' favorite subject was math?

a. Is this an example of experimental or theoretical probability?

b. Is this event bias or unbiased?

Answer Key for Scavenger Hunt Questions

1a. Theoretical probability (this answer is based on here belief that she will be offered the job. There are only two choices either she will be offered the job or she won't be offered the job).

1b. This event is unbiased because her being offered one job won't affect her chances of being offered the other jobs.

2a. This is an example of experimental probability.

2b. This event is bias because there are more red marbles in the bag than blue marbles.

3a.This is an example of theoretical probability because she has not performed the experiment yet. Theoretically these 8 outcomes could happen, but it is no guarantee that all eight will happen.

3b. This event is unbiased because one flip of the coin will not affect the outcome of the other flips of the coin.

4a. This is an example of experimental probability.

4b.This event is bias because the spinner is not divided evenly.

5a. This is an example of experimental probability.

5b. This event is unbiased because all four restaurants have an equal chance of being chosen.

6a. This is an example of experimental probability.

6b.This event is unbiased because each student have an equally like chance of being chosen.

Probability Classwork   Name: _____

Date: _____

Using the events from the scavenger hunt, calculate the probability of each event happening. Each question # refers to the corresponding scavenger hunt number (ex # 1 from the scavenger hunt refers to # on this Classwork sheet.

1. What is the probability that Janice will be offered each of the jobs? Write your answer as a fraction

2. What is the probability that Mrs. Green will select a blue marble out of the bag? How does her results compare to the result we got from our experiment in the beginning of class?

3. Calculate the probability that exactly two of Kim coins will land on heads.

4. Mr. Green believes that he has an equal chance of getting a half day as he does working all day. Is he correct? Why, or Why not?

5. What is the probability that Jamie will eat lunch at Subway? Does she have an equally likely chance of eating lunch at Popeye's?

6. Calculate the probability that Mr. Green will find a student at lunch time whose favorite subject is Math?

Using the events from the scavenger hunt, calculate the probability of each event happening. Each question # refers to the corresponding scavenger hunt number (ex # 1 from the scavenger hunt refers to # on this Classwork sheet.

1. What is the probability that Janice will be offered each of the jobs? Write your answer as a fraction.
   Janice has a 1/2*1/2*1/2*1/2= 1/16   or 6.25% of being offered each job.

2. What is the probability that Mrs. Green will select a blue marble out of the bag? How does her results compare to the result we got from our experiment in the beginning of class?
   The class data came out to be 10/30 = 33% chance of picking a blue.

   It is a 1/10 = 10% chance that Mrs. Green will select a blue marble. There is

   a 23% difference from the experimental and the theoretical probability.

3. Calculate the probability that exactly two of Kim coins will land on heads.
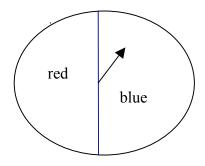   **There is a 3/8 = 27.5% (28%) chance that exactly two of Kim coins will land on heads**

4. Mr. Green believes that he has an equal chance of getting a half day as he does working all day. Is he correct? Why, or Why not?
   No, this is not correct because the spinner is not divided evenly. He has less of a chance of getting a half day off. He has more of a chance of working all day.

5. What is the probability that Jamie will eat lunch at Subway? Does she have an equally likely chance of eating lunch at Popeye's?
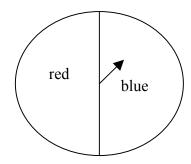   **Jamie has a 25% chance of eating lunch at Subway. Yes, Jamie has as equally likely chance of eating lunch at Popeye's.**

6. Calculate the probability that Mr. Green will find a student at lunch time whose favorite subject is Math?
   Mr. Green has a 20% chance of finding a student at lunch time whose favorite subject is Math.

Fair or Unfair?

Two fair spinners are part of a school fun day game. A player wins a prize only when both arrows land in the red areas after each spinner has been spun once. Mr. Green is playing the game.

1. Mr. Green thinks that he has a 50–50 chance of winning. Do you agree of disagree with Mr. Green? _____ Why?

2. If you play the game 10 times, how many times would you expect to win? _____

3. Working with a partner, use actual spinners to gather data on 10 games.   Record you results in any way you wish.

4. a. If you played the game another 10 times, how many times would you expect to win? _____

     c.   Is this prediction the same as your first prediction for 10 games in number 2?

5. a. Graph your results from problem #3 on graph paper. Using the calculator, gather data on 20 games, 50 games, and 100 games. (Display the data using one graph for each set of data).

Fair or Unfair?   Answer Key

Two fair spinners are part of a school fun day game. A player wins a prize only when both arrows land in the red areas after each spinner has been spun once. Mr. Green is playing the game.
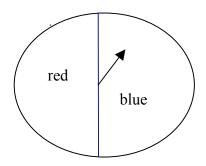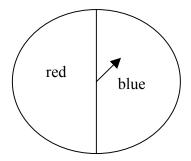

1. Mr. Green thinks that he has a 50–50 chance of winning. Do you agree of disagree with Mr. Green? _____ Why?

No, Mr. Green has a 25% chance that both of the spinners will land on the red at the same time.

2. If you play the game 10 times, how many times would you expect to win? _____

If you played the game 10 times, you would be expected to win 2 or 3 times. (based in the theoretical probability)

3. Working with a partner, use actual spinners to gather data on 10 games.   Record you results in any way you wish.

Answers will vary.

4. a. If you played the game another 10 times, how many times would you expect to win? _____

Answers will vary

b. Is this prediction the same as your first prediction for 10 games in number 2?

Why, or why not?

Answers will vary

5. a. Graph your results from problem #3 on graph paper. Using the calculator, gather data on 20 games, 50 games, and 100 games. (Display the data using one graph for each set of data).

  Graphs will vary

  b. What observation, if any can you make about these graphs?

  Answers will vary

Probability **Homework**

Answer each of the following questions. **Show all work!**

1. The administration needs to pick a seventh or an eighth grade student from the school to attend a meeting to discuss how they like the new school.   There are 165 seventh and 185 eighth grade students in the school.

2. The eighth grade class will give a free class trip ticket to one eight grader in the class. There are 230 boys and 270 girls.

3. Ford Motors made a new car model. You may select from 3 different colors of paint, 4 cylinder engines or 6 cylinder engines, and 2 different shades for the interior of the car. How many different varieties of the new model car are there?

4. A restaurant sells cola in small, medium, and large sizes. They offer cherry cola, vanilla cola, and regular cola. They also sell each cola in a caffeine and non–caffeine version. How many different varieties of cola does the restaurant sell?

5. A survey shows $\dfrac{1}{4}$ of the students eat at Mc Donald's. What device could be used to demonstrate the probability that a student chosen will eat at Mc Donald's?

    A. Six–sided number cube   B.   Spinner with 3 equal sections
    C. Fair coin   <u>X</u> D. Standard deck of 52 playing cards

Probability Homework Answer Key

Answer each of the following questions. **Show all work!**

1. The administration needs to pick a seventh or an eighth grade student from the school to attend a meeting to discuss how they like the new school. There are 165 seventh and 185 eighth grade students in the school.

165/350 = 47% a. What is the probability that a seventh grade student will be selected in a random drawing?

185/350 =53% b.What is the probability that an eighth grade student will be selected in a random drawing?

2. The eighth grade class will give a free class trip ticket to one eight grader in the class. There are 230 boys and 270 girls.

230/500 = 46% a. What is the probability that a boy would be selected in a random drawing?

270/500 = 54% b.What is the probability that a girl would be selected in a random drawing?

3. Ford Motors made a new car model. You may select from 3 different colors of paint, 4 cylinder engines or 6 cylinder engines, and 2 different shades for the interior of the car. How many different varieties of the new model car are there?
   12
   (3colors * 2 cylinders* 2 interior shades)

4. A restaurant sells cola in small, medium, and large sizes. They offer cherry cola, vanilla cola, and regular cola. They also sell each cola in a caffeine and non–caffeine version. How many different varieties of cola does the restaurant sell?
   18
   (3sides* 3flavors* 2versions)

5. A survey shows $\frac{1}{4}$ of the students eat at Mc Donald's. What device could be used to demonstrate the probability that a student chosen will eat at Mc Donald's?

   A. Six–sided number cube   B.   Spinner with 3 equal sections
   C. Fair coin   X D. Standard deck of 52 playing cards

Hero Figures   Name: _____
                                                Date: _____

Trial: Collection of Hero Figures

McDonald's has just announced a new promotion, where they are given away
super hero figures. There are 10 different action figures. The figure that you
want is the Superman figure and your friend wants Spiderman. The figures are
given out randomly so no one knows which figure is Superman or Spiderman.

You truly don't like McDonald's food, but you really want that Superman
figure, so you want to make as few purchases as possible to get the figure. On
the other hand, your friend loves McDonald's food, and he said that he wants
to get 10 Spiderman figures.

The promotion states that each figure is equally likely to be distributed. If this
is true, how many meals do you think you will have to buy before you get one
Superman figure? How many meals do think your friend will have to purchase
before he gets 10 Spiderman figures?

Designing the experiment

- **What are the outcomes?**

- **What is the theoretical probability of each outcome?**

- **What are you assuming?**

- **What random device will you use to model (conduct) the situation?**

- **How will you use this device?**

- **What does one trial represent?**

- **How will you conduct one trial?**

Hero Figures   Answer Key

Trial: Collection of Hero Figures

McDonald's has just announced a new promotion, where they are given away super hero figures. There are 10 different action figures. The figure that you want is the Superman figure and your friend wants Spiderman. The figures are given out randomly so no one knows which figure is Superman or Spiderman.

You truly don't like McDonald's food, but you really want that Superman figure, so you want to make as few purchases as possible to get the figure. On the other hand, your friend loves McDonald's food, and he said that he wants to get 10 Spiderman figures.

The promotion states that each figure is equally likely to be distributed. If this is true, how many meals do you think you will have to buy before you get one Superman figure? How many meals do think your friend will have to purchase before he gets 10 Spiderman figures?

Answers will vary

Designing the experiment

- **What are the outcomes?**
    10

- **What is the theoretical probability of each outcome?**

    1/10
- **What are you assuming?**
That each time you go to McDonald's you will get a different super hero figure.

- **What random device will you use to model (conduct) the situation?**
I would use a random number generator to model this situation.

- **How will you use this device?**

I would set the random number generator from 1-10

- **What does one trial represent?**

1 trial represents the purchase of one meal.

- **How will you conduct one trial?**

Data Collection Sheet

Conduct 20 trials. Record your trials here.

1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	
25.	

Tally Worksheet II
Independent Data

Number of times ate at McDonald's	Frequency	Total
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
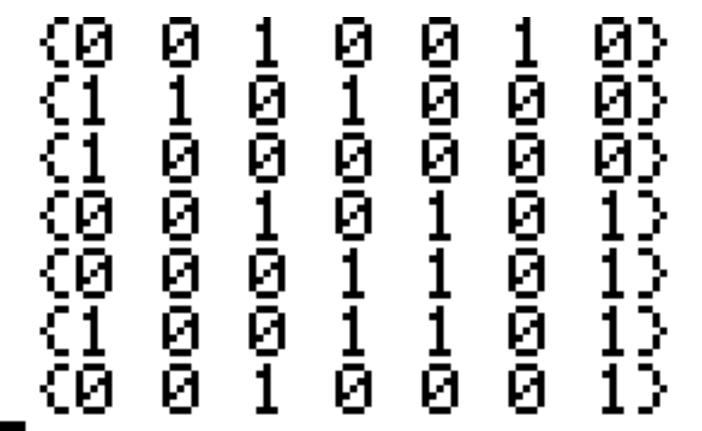
Tally Worksheet III
Pair/Share Data

Number of times ate at McDonald's	Frequency	Frequency
	Pair data (2 people)	Share data (4 people)
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		

Tally Worksheet IV
Class Data

Number of times ate at McDonald's	Frequency Total Individual	Frequency Total Whole class
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		

Simulation Table

$$\begin{Bmatrix} 0 & 0 & 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 1 & 0 & 1 \\ 1 & 0 & 0 & 1 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 & 0 & 1 \end{Bmatrix}$$

| Free Throw tally sheet | | |
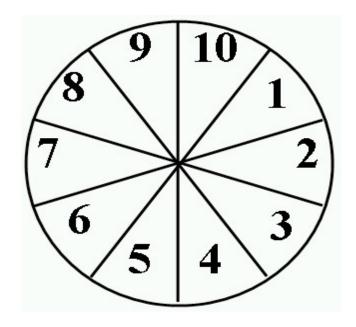
Free Throw tally sheet

# of trials	Simulation tally	Trash can tally
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Using you simulation tally estimate the following probabilities:

1.
   a. making 100% of your shots

   b. making at least 75% or more of your shots

   c. making at least 50% of you shots

   d. making less than 25 % of your shots

2. What is the probability of the trash can shot?

3. Compare the simulation probability and the trash can probability are the results the same?

Formula assessment

BCR (problem #6 2006 H.S.A.)

A cereal company awards a prize to anyone who collects all 5 different game pieces. Each game piece has an equal chance of being placed in a box of cereal. Each box of cereal contains only 1 game piece.

Complete the following:

Design a simulation of at least 30 trials that can be used to estimate how many boxes of cereal a person needs to buy to collect all 5 different game pieces. Describe how to collect and interpret the data so that you have confidence in the estimation.

Sample answer key for BCR

Answers will vary; here is a possible answer.

Create a spinner with 5 equal size sections numbered 1, 2, 3, 4, and 5. Spin the spinner until every number has been spun. Repeat this process 30 times. Add up the number of times it took to get all the numbers on the spinner on all 30 trails. Then divide that by 30 you find the expected amount of cereal boxes someone would have to buy in order to get all 5 game pieces.